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SERVO CONTROLLER OF SPINDLE MOTOR FOR OPTICAL DISC

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[There are no amendments to this patent.]

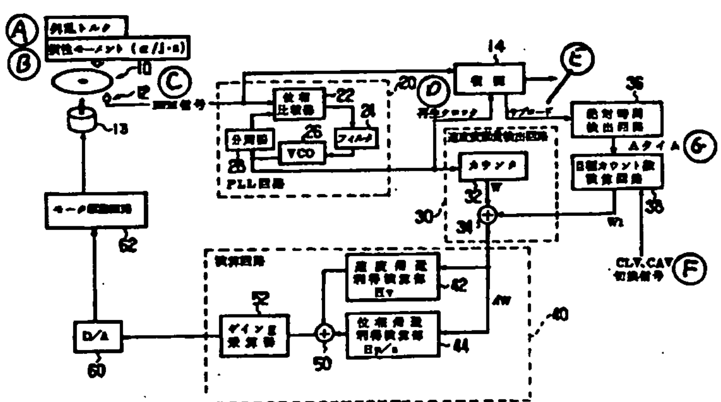
Abstract

Problem

To be able to implement both CLV control and CAV control in a digital servo controller of a spindle motor for an optical disc.

Means to solve

A PLL circuit 20 generates a regenerated clock signal for an EFM signal from an optical disc 10. An absolute time detector 36 detects absolute time information indicated by a subcode of a demodulated signal obtained by a demodulator 14, and a target count number arithmetic circuit 38 produces a playback position on the optical disc by the absolute time information and calculates a target count number W1 for the linear velocity corresponding to the playback position. A velocity change detector 30 detects the amount ΔW of velocity change from the difference between the above-mentioned target count number W1 and an actual regenerated clock signal count number W. An arithmetic circuit 40 calculates a feedback control signal based on ΔW, where $\Delta W \fallingdotseq 0$, and a motor 13 is feedback-controlled by the signal. In a CAV system, W1 is sequentially changed in accordance with the playback position, and in a CLV system, W1 is set to a determined linear velocity and feedback-controlled, so that either CLV or CAV can be controlled by a CLV servo loop.



Key:

Key:	A	Disturbance torque
	B	Moment of inertia (α/j·s)
	C	EFM signal
	D	Regenerated clock signal
	E	Subcode
	F	CLV and CAV switching signal
	G	A time
	14	Demodulation
	20	PLL circuit
	22	Phase comparator
	24	Filter
	28	Frequency divider
	30	Velocity change detector
	32	Counter
	36	Absolute time detector
	38	Target count number arithmetic circuit

40 Arithmetic circuit
42 Velocity feedback gain arithmetic unit H_v
44 Phase feedback gain arithmetic unit $H_{p/s}$
52 Gain g multiplier
62 Motor driving circuit

Claims

1. Servo controller of a spindle motor for an optical disc that feedback-controls a spindle motor of an optical disc device, characterized by the fact that it is equipped with a velocity change detection means that detects the amount of velocity change between the linear velocity of the rotation of an optical disc and a target linear velocity, an arithmetic means that calculates the amount of feedback control for the above-mentioned spindle motor based on the above-mentioned amount of velocity change, an absolute time detection means that detects absolute time information corresponding to a playback position on the optical disc from a signal read from the above-mentioned optical disc, and a target linear velocity arithmetic means that generates a fixed target linear velocity in a constant linear velocity system in accordance with a switching signal and sequentially calculates a target linear velocity at the playback position on the above-mentioned optical disc based on the above-mentioned absolute time information detected in a constant angular velocity system; and that a servo control according to either a constant linear velocity system or a constant angular velocity system can be selectively implemented.

2. Servo controller of a spindle motor for an optical disc that feedback-controls a spindle motor of an optical disc device, characterized by the fact that it is equipped with an absolute time detection means that detects absolute time information corresponding to a playback position on an optical disc from a signal read from the above-mentioned optical disc, a target linear velocity arithmetic means that calculates a target linear velocity at the playback position on the above-mentioned optical disc based on the above-mentioned detected absolute time information, a velocity change detection means that detects the amount of velocity change between the linear velocity of the rotation of the optical disc and the above-mentioned target linear velocity, and an arithmetic means that calculates the amount of feedback control for the above-mentioned spindle motor based on the above-mentioned amount of velocity change; and that a constant angular velocity system is servo-controlled by supplying the above-mentioned feedback control signal corresponding to the above-mentioned amount of feedback control to the spindle motor.

3. Servo controller of a spindle motor for an optical disc claimed in Claim 1 or 2, characterized by the fact that the above-mentioned target linear velocity arithmetic means calculates the distance from the center of the above-mentioned optical disc to the playback position based on the above-mentioned absolute time information and calculates the

above-mentioned target linear velocity at the corresponding playback position based on the above-mentioned distance.

4. Servo controller of a spindle motor for an optical disc claimed in Claim 1 or 2, characterized by the fact that the above-mentioned velocity change detection means is equipped with a counter that counts a regenerated clock signal generated from an input signal obtained by reading the above-mentioned optical disc; that the above-mentioned target liner velocity arithmetic means produces the above-mentioned target linear velocity as a target count number of the regenerated clock signal in a fixed time; and that the above-mentioned velocity change detection means detects the difference between the count number of the regenerated clock signal corresponding to the input signal to the above-mentioned counter and the target count number calculated by the above-mentioned target linear velocity arithmetic means as an amount of velocity change.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention pertains to a constitution of a servo controller of a spindle motor for an optical disc such as a CD (compact disc). In particular, it pertains to a servo controller that can implement velocity control for both constant linear velocity (CLV) and constant angular velocity (CAV).

[0002]

Prior art

During the reading and playback of signals recorded on an optical disc, such as a CD or a CD-ROM, in a constant linear velocity (CLV) system, the angular velocity of a spindle motor for the optical disc is controlled so that playback of digital signals obtained during reading of the optical disc within a fixed period can be a constant amount.

[0003]

Figure 2 is an outlined constitutional diagram showing a conventional servo controller of a spindle motor of a CLV system. An optical disc 10 is rotated and driven by a spindle motor 13, and data stored on the optical disc 10 are read as analog signals by photodiodes of a pickup part 12. The analog signals are RF (high frequency) amplified and converted into a digital RF signal, so that EFM (Eight to Fourteen Modulation) signals are obtained.

[0004]

A PLL circuit 20 equipped with phase comparators 22, filter 24, VCO 26, and frequency divider 28 generates a synchronized regenerated clock signal from the EFM signals.

[0005]

The regenerated clock signal is supplied as a regenerated clock signal for a demodulator 14 and a frequency comparator 15. The frequency comparator 15 compares a frequency fg of the regenerated clock signal and a frequency fref of a reference frequency signal and outputs a frequency difference Δf (= fref - fg).

[0006]

A velocity feedback gain controller 16 outputs a velocity error H_v proportional to said Δf based on the above-mentioned frequency difference Δf. Also, a phase feedback gain controller 17 integrates the frequency difference Δf and outputs a phase error $H_{p/s}$, and an adder 18 adds two error signals, the velocity error H_v and the phase error $H_{p/s}$. An amplifier 19 amplifies the sum signal by a fixed feedback gain g. Then, if an output analog signal from the amplifier 19 is output as a driving signal to a motor driving circuit 62, the spindle motor 13 is driven in response to this signal, and the optical disc 10 is rotated.

[0007]

With the feedback control of such a servo loop, the frequency fg of the playback signals obtained from the PLL circuit 20 is matched to the frequency fref corresponding to a target angular velocity (target linear velocity), and the spindle motor is velocity-controlled so that the linear velocity is constant.

[0008]

Also, the EFM signals are synchronously detected and demodulated based on the regenerated clock signal in the demodulator 14. Furthermore, the demodulated data are subjected to error correction processing, etc., in a latter stage and regenerated as audio signals or video signals.

[0009]

The CD on which voice information is recorded is usually regenerated by using the above-mentioned servo controller of the CLV driving system.

[0010]

On the other hand, with CD-ROMs, the CAV driving system for constant angular velocity is used. Then, in controlling the angular velocity of the CD-ROM of the CAV system, for example, a magnetization for a FG (Frequency Generator) is applied to a rotor motor, and with the magnetization, the angular velocity of the motor is based on the FG signal generated by the coil for FG, and the velocity is controlled so that the angular velocity is constant.

[0011]

Problem to be solved by the invention

In current signal regenerators for optical discs, there is the demand for playback using both the CLV system and the CAV system with different optical disc sizes and velocity control systems in the same device. In the CLV system in which the linear velocity is constant, that is, the angular velocity is changed according to the playback position and in the CAV system in which the angular velocity is always constantly maintained regardless of the playback position, the reference used by the control for the angular velocity of the spindle motor is different. In other words, in the CLV system, the feedback control is carried out based on the obtained playback signal, while in the CAV system, the feedback control is carried out based on the FG signal.

[0012]

Therefore, both driving systems cannot be controlled simply by a single conventional servo loop. For this reason, to provide servo control for both the CLV system and the CAV system, it is necessary to install an additional angular velocity change detecting mechanism for CAV for detecting the velocity from the FG signal for CAV and its corresponding servo control mechanism in addition to the servo control mechanism for CLV as shown in Figure 2.

[0013]

The present invention solves such a problem, and its purpose is to provide a digital servo controller that can implement both the CLV system and the CAV system. Also, its purpose is to provide a new digital servo controller for the CAV system using a constitution for realizing the CLV system.

[0014]

Means to solve the problem

The present invention is a servo controller that feedback-controls a spindle motor of an optical disc device, characterized by the fact that it is equipped with a velocity change detection means that detects the amount of velocity change between the linear velocity of the rotation of an

optical disc and a target linear velocity, an arithmetic means that calculates the amount of feedback control for the above-mentioned spindle motor based on the above-mentioned amount of velocity change, an absolute time detection means that detects absolute time information corresponding to a playback position on the optical disc from a signal read from the above-mentioned optical disc, and a target linear velocity arithmetic means that generates a fixed target linear velocity in a constant linear velocity system in accordance with a switching signal and sequentially calculates a target linear velocity at the playback position on the above-mentioned optical disc based on the above-mentioned absolute time information detected in a constant angular velocity system; and that a servo control according to either a constant linear velocity system or a constant angular velocity system can be selectively implemented by these means.

[0015]

Also, the present invention is characterized by the fact that it is equipped with an absolute time detection means that detects absolute time information corresponding to a playback position on an optical disc from a signal read from the above-mentioned optical disc, a target linear velocity arithmetic means that calculates a target linear velocity at the playback position on the above-mentioned optical disc based on the above-mentioned detected absolute time information, a velocity change detection means that detects the amount of velocity change between the linear velocity of the rotation of the optical disc and the above-mentioned target linear velocity, and an arithmetic means that calculates the amount of feedback control for the above-mentioned spindle motor based on the above-mentioned amount of velocity change; and that a constant angular velocity system is servo-controlled by supplying the above-mentioned feedback control signal corresponding to the above-mentioned amount of feedback control to the spindle motor.

[0016]

Furthermore, the present invention is characterized by the fact that the above-mentioned target linear velocity arithmetic means calculates the distance from the center of the above-mentioned optical disc to the playback position based on the above-mentioned absolute time information and calculates the above-mentioned target linear velocity at the corresponding playback position based on the above-mentioned distance.

[0017]

Also, the present invention is characterized by the fact that the above-mentioned velocity change detection means is equipped with a counter that counts a regenerated clock signal generated from an input signal obtained by reading the above-mentioned optical disc; that the above-mentioned target linear velocity arithmetic means produces the above-mentioned target

linear velocity as a target count number of the regenerated clock signal in a fixed time; and that the above-mentioned velocity change detection means detects the difference between the count number of the regenerated clock signal corresponding to the input signal to the above-mentioned counter and the target count number calculated by the above-mentioned target linear velocity arithmetic means as an amount of velocity change. In this way, the counter counts the regenerated clock signal, so that the amount of velocity change can be detected in digital processing.

[0018]

Embodiment of the invention

Next, an embodiment of the present invention is explained using the figure. Also, the same symbols are given to identical parts from the above-mentioned Figure 2, and their explanation is not repeated.

[0019]

In the servo controller of this embodiment, a spindle motor can be velocity-controlled by a servo loop using linear velocity control so that its linear velocity is constant or its angular velocity is constant. Figure 1 shows the constitution of such a digital servo controller of a spindle motor for an optical disc.

[0020]

A PLL circuit 20 generates a regenerated clock signal from an EFM signal obtained by reading a rotary optical disc 10, and the regenerated clock signal is supplied to a demodulator 14 and also supplied to a velocity change detector 30.

[0021]

The velocity change detector 30 is equipped with a counter 32 and a subtracter 34. The counter 32 counts the regenerated clock signal from the PLL circuit 20 for each prescribed reference period T, and the subtracter 34 compares the count number W of the counter 32 and a target count number W1 calculated as described later and produces the amount of change between the linear velocity of an actual rotation and a target linear velocity as an amount ΔW ($\Delta W = W - W1$) of velocity change.

[0022]

An absolute time detector 36 detects a subcode from a demodulated signal obtained by demodulating the EFM signal based on the regenerated clock signal by the demodulator 14, detects the absolute time information (A time) of the subcode, and supplies the absolute time

information to a target count number arithmetic circuit 38. The absolute time information is indicated by the subcode stored every 98 data frames on the optical disc 10 and indicates a required pickup time from a readout reference position (the innermost tracks of the disc) of the optical disc to the position where the absolute time information is stored.

[0023]

The target count number arithmetic circuit 38 produces the corresponding target count number W1 as follows, based on CLV and CAV switching signals supplied from microcomputers not shown in the figure. Here, the target count number W1 is a count number of the regenerated clock signal to be counted for a reference period T when the rotation of the optical disc 10 is a target velocity, that is, a target count number corresponding to the linear velocity.

[0024]

When the switching signal indicates a CAV system, the target count number arithmetic circuit 38 calculates the target count number W1 as follows.

[0025]

First, the target count number arithmetic circuit 38 calculates the radius r from the center of the optical disc 10 to a playback position by the following equation (1) using the absolute time information at(t).

[0026]

Equation 1

$$r = \sqrt{\frac{at \cdot v \cdot tp}{2\pi} + r1^2}$$

r: Radius from the center of the optical disc to a playback position (mm)
at: Absolute time from the innermost periphery (t)
v: Liner velocity (mm/t)
tp: Track pitch (mm)
r1: Radius from the center of the optical disc to the innermost tracks (mm) (1)

Next, the target count number arithmetic circuit 38 calculates the following equation (2) using the radius r and produces the target count number W1 corresponding to the target linear velocity corresponding to the playback position.

[0027]
Equation 2

$$W1 = (r/r1) \times W0 \qquad (2)$$

In the above equation (2), W0 is the count number of the regenerated clock signal regenerated by the PLL circuit within the period T at the innermost tracks. Then, the arithmetic processing of the above-mentioned target count number W1 is implemented each time the absolute time information is detected by the demodulated signal.

[0028]
When a table of the target count number W1 corresponding to the radius r is installed in advance, the count number W1 corresponding to the calculated radius r is read from the table each time the absolute time information is detected without calculating the equation (2), and it is supplied to the subtracter 34 of the velocity change detector 30. In this way, in the CAV system, the target count number W1 showing the linear velocity corresponding to the playback position on the optical disc 10 is set so that it increases toward the outer periphery of the optical disc.

[0029]
Next, if the switching signal indicates a CLV system, the target count number arithmetic circuit 38 supplies the count number corresponding to a preset linear velocity as the target count number W1 to the above-mentioned subtracter 34 and maintains the value.

[0030]
As mentioned above, the target count number arithmetic circuit 38 produces the corresponding target count number W1 for both the CLV system and the CAV system, and it supplies this number to the subtracter 34 of the velocity change detector 30 and compares it to the count number W of an actual regenerated clock signal, so that the amount ΔW of velocity change is detected.

[0031]
An arithmetic circuit 40 is equipped with velocity feedback gain arithmetic unit 42, phase feedback gain arithmetic unit 44, adder 50, and gain multiplier 52.

[0032]
The velocity feedback gain arithmetic unit 42 produces a velocity error H_v proportional to ΔW based on the amount ΔW of velocity change detected by the above-mentioned velocity

change detector 30. The phase feedback gain arithmetic unit 44 produces the corresponding phase error (an integrated value of ΔW) by integrating the amount ΔW of velocity change and calculates a phase error $H_{p/s}$. Then, the adder 50 adds two error signals of the velocity error H_v and the phase error $H_{p/s}$ and outputs the added signal to the gain multiplier 52.

[0033]

The gain multiplier 52 multiplies a feedback gain g to the added signal obtained from the adder 50 and supplies any of the calculated feedback control signals based on the multiplication result to D/A 60. Also, the D/A 60 converts the supplied control signal into an analog signal and supplies it as an analog driving signal to a motor driving circuit 62. Then, the spindle motor 13 is driven based on the driving signal, and as a result, the optical disc 10 is controlled so that it is rotated at the linear velocity corresponding to the target count number W1.

[0034]

As mentioned above, in this embodiment using the CAV system, the target count number arithmetic circuit 38 sequentially calculates the target count number W1 based on the absolute time information, that is, the playback position on the optical disc 10. For this reason, the target count number W1 is feedback-controlled to $W \fallingdotseq 0$, so that the linear velocity is changed in accordance with the playback position. The spindle motor 13 is controlled so that it is rotated at a constant velocity. Therefore, CLV and CAV can be controlled simply by adding the constitution in which the target count number W1 is variable in accordance with the playback position, and a servo loop which detects the angular velocity of the spindle motor 13 by FG signals and controls it to a constant angular velocity is not required.

[0035]

Also, if DSP is realized in hardware, since the target count number arithmetic circuit 38 and the arithmetic circuit 40 can be implemented by software processing of the DSP, both systems can be realized using the same hardware.

[0036]

Effect of the invention

As explained above, according to the present invention, a digital servo of both the CLV system and the CAV system can be realized by a simple constitution. In particular, if DSP, etc., are used, both systems can be implemented using the same hardware simply by switching the software.

Brief description of the figures

Figure 1 shows the constitution of the servo controller of a spindle motor for an optical disc of the embodiment of the present invention.

Figure 2 shows the constitution of a conventional servo controller of a spindle motor for an optical disc.

Explanation of symbols

10	Optical disc
12	Pickup
13	Spindle motor
14	Demodulator
20	PLL circuit
30	Velocity change detector
32	Counter
34	Subtracter
36	Absolute time detector
38	Target count number arithmetic circuit
40	Arithmetic circuit
42	Velocity feedback gain arithmetic unit
44	Phase feedback gain arithmetic unit
50	Adder
52	Gain multiplier
60	D/A
62	Motor driving circuit

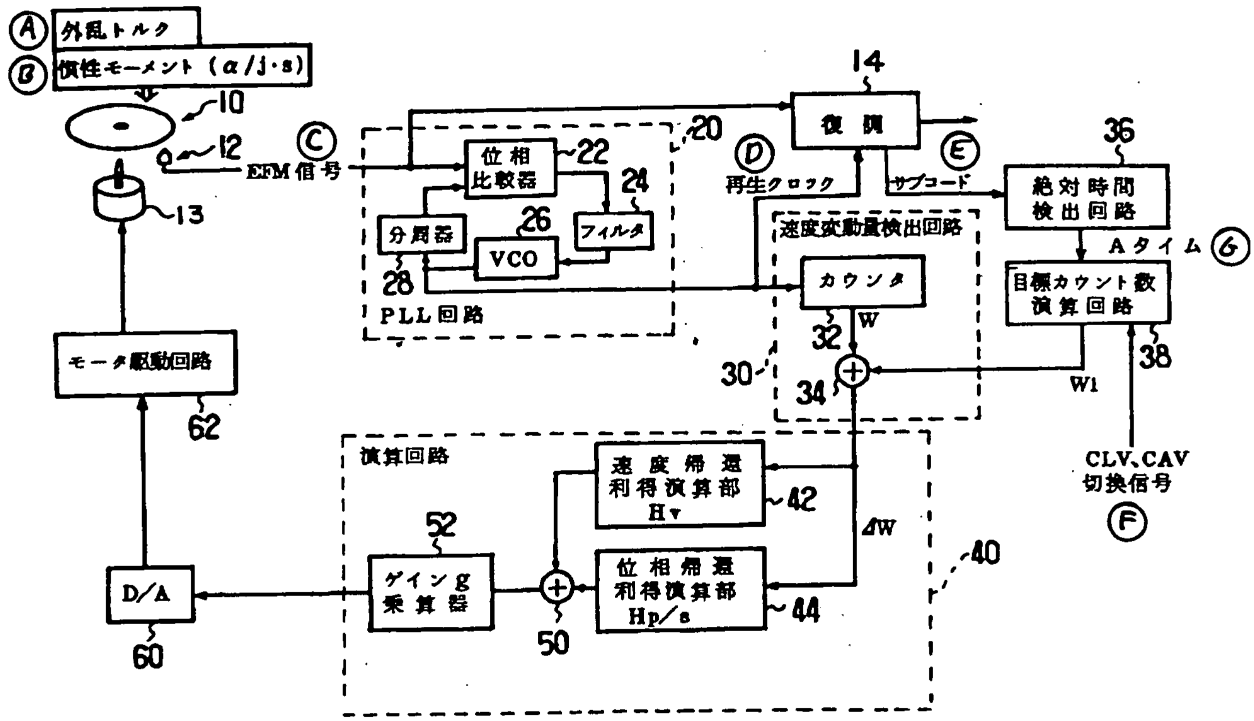


Figure 1

Key:		
	A	Disturbance torque
	B	Moment of inertia (α/ j·s)
	C	EFM signal
	D	Regenerated clock signal
	E	Subcode
	F	CLV and CAV switching signal
	G	A time
	14	Demodulation
	20	PLL circuit
	22	Phase comparator
	24	Filter
	28	Frequency divider
	30	Velocity change detector
	32	Counter
	36	Absolute time detector
	38	Target count number arithmetic circuit
	40	Arithmetic circuit
	42	Velocity feedback gain arithmetic unit H_v
	44	Phase feedback gain arithmetic unit $H_{p/s}$
	52	Gain g multiplier
	62	Motor driving circuit

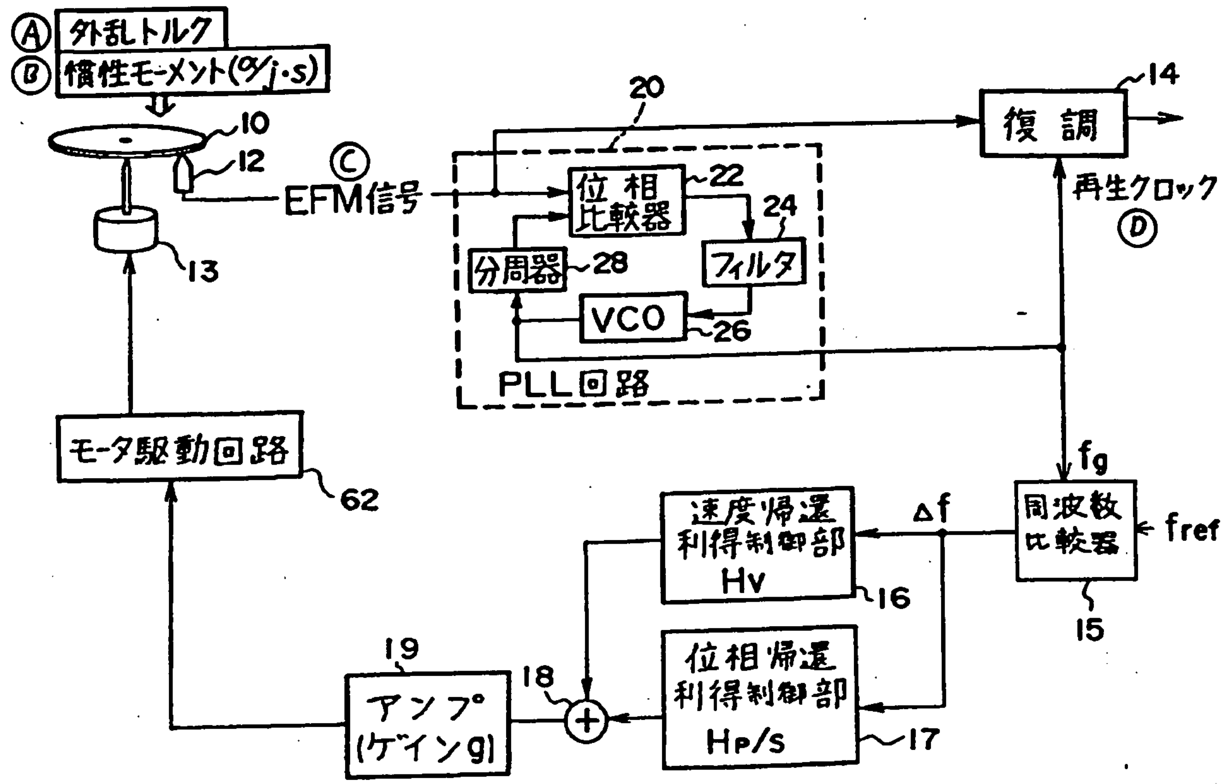


Figure 2

Key:	A	Disturbance torque
	B	Moment of inertia (α/j·s)
	C	EFM signal
	D	Regenerated clock signal
	14	Demodulation
	15	Frequency comparator
	16	Velocity feedback gain controller H_v
	17	Phase feedback gain controller $H_{p/s}$
	19	Amplifier (gain g)
	20	PLL circuit
	22	Phase comparator
	24	Filter
	28	Frequency divider
	62	Motor driving circuit

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